CHAPTER 4

# RECOVERY OPERATIONS

**Recovery is a big job. Prior to any recovery, calculate resistance, inspect your tackle, and keep a rigging reference handy. A haphazard approach to recovery can lead to death, dismemberment, and damaged equipment. THINK SAFETY.**

## SAFETY PRECAUTIONS

### INTRODUCTION

A successful recovery operation is accomplished quickly and safely. Be careful when erecting and using equipment. This prevents damage to the vehicles and equipment and injury to personnel.

### ACCELERATION IMPACT

Do not apply loads suddenly (shockload). This puts excessive strain on the equipment and it may fail. Failure occurs when a weight is allowed to fall for a distance and is suddenly stopped. A similar strong force happens when power is engaged suddenly.

## BACKLASH

Take extra care to avoid accidents. Make every effort to stand clear of wire rope under tension. When wire rope is drawn taut and then released suddenly by a break, its recoil (or backlash) will cut a person in two. A winch line under load stretches like a rubber band and stores up a lot of energy. In fact, a steel winch cable weighing 50 to 500 pounds has a better spring than rubber. A broken winch cable snapping back could be compared with a rifle bullet, except the bullet makes a fairly clean hole and the winch cable makes a messy wound. Treat a wire rope under tension with the same respect you would a loaded gun.

## CROSSED CABLES

Make sure the rigging lines are not crossing each other before the winching operation is continued. Crossed rigging lines can rub against each other causing damage to the cable or an increased amount of tackle resistance. Crossed cables are only recommended for towing a disabled vehicle.

## FUEL OR OIL SPILLAGE

If fuel or oil has spilled from the disabled vehicle, there must be **NO SMOKING** and **NO OPEN FLAMES**. Make sure the exhaust flash from other vehicles is not directed at the vehicle with spilled fuel or oil. Clean up spilled fuel or oil thoroughly before attempting to start the recovery vehicle's engine. When winching or lifting a disabled fuel carrier, thoroughly ground the vehicle to keep static electricity from igniting the fuel. The POL carrier should have the necessary grounding equipment.

Fuel, oil and other mechanical fluids commonly spilled on the ground during BDAR operations can cause great damage to the environment. As with many BDAR considerations, the level of environmental protection will be mission dependant. Even in periods of heightened conflict, simple steps can help to conserve and protect our fragile environment. All practical efforts should be made to avoid environmental contamination. Spills over one gallon should be reported through the chain of command to the unit's logistical element, such as the battalion S4.

## GROUND GUIDES

For safe control of a recovery operation, there should be two ground guides to prevent confusion. One ground guide in the front, and one in the rear, one ground gives the signals. The ground guides should stand apart from other personnel at the recovery site and be in a position where operators can easily observe the signals. The operators must know the meaning of the signals to be used and act only on those signals (See Appendix C).

*CAUTION:*

*A winch line makes a deadly slingshot. If the dead line of a snatch block breaks, a 200-pound snatch block can travel as far as 300 yards in the air. All personnel observing should stand at least one cable length away from and opposite the angle of pull when the cable is under stress.*

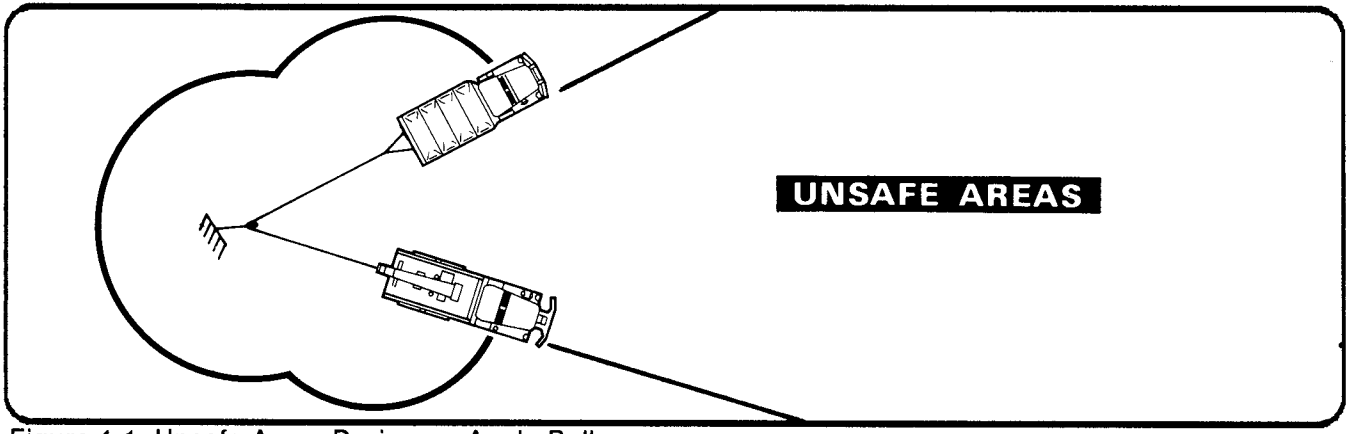



Figure 4-1. Unsafe Areas During an Angle Pull

## HANDLING CABLES

Cables and wire ropes may become damaged through use. The wires that make up the strands of the rope may break. Personnel handling wire ropes should wear heavy, leather-palmed gloves to prevent hand injuries or cuts from broken wires. Never allow a moving cable to slide through the hands even when gloves are worn since broken wires can cut through the gloves. Never step over a cable under tension.

## HOOK POSITIONS

For rigging, position the hook with the open part (throat) upward. If the hook should straighten out from overload, the rigging would be forced downward. If the hook were positioned with the open part (throat) down, the rigging would travel upward unrestricted and cause serious injury to personnel or damage to vehicles.

## HOLDBACK VEHICLES

Towing track vehicles may require the use of a holdback vehicle. When using tow bars, if the recovery vehicle is lighter than the disabled vehicle, a holdback vehicle or braking method (that is, a driver with operable brakes in the towed vehicle) is required. A holdback vehicle or braking method is mandatory when using tow cables.

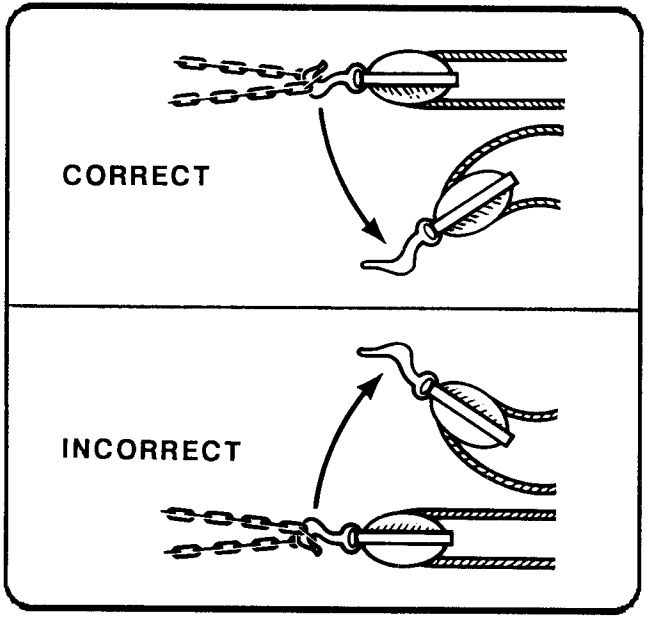



Figure 4-2. Hook Positions

*CAUTION:*
*Take care to avoid injury to crew members and equipment caused by heat generated from combat vehicle exhaust systems. See TB 43-0001-39-1 for guidance on construction of an exhaust grate heat deflector.*

## INSPECT RIGGING

Inspect equipment thoroughly before the recovery operation starts. Direct the recovery vehicle operator to apply power to the winch to remove the slack from the rigging; then stop the operation so that the rigging can be inspected without endangering personnel.

## OPERATOR/DRIVER SAFETY

Operators and other personnel, in both the recovery and disabled vehicles, should keep their hatches closed during a recovery operation and use their periscopes to view hand signals.

## POSITIONING GUN TUBES

During tank recovery, position the main gun tube so that it will not be damaged. If the gun tube of a disabled tank is involved in a collision (this might occur on a nosed or overturned tank), support maintenance personnel should always check the gun before firing.

## RIGGING BETWEEN VEHICLES

While rigging is being erected between vehicles, turn off the engines and apply the brakes. This prevents possible injury to the recovery personnel or damage to the vehicles. When riggings are erected using a recovery vehicle that must have its engine running to operate the equipment, position the spade or chocks (wheel vehicle) and apply the brakes to prevent movement. The driver will remain in position.

## SAFETY KEYS AND SHACKLE PINS

Safety devices/keys should be in place on all tow hooks, shackles, or other items of equipment. Even though the safety device/key supports no great load, its absence can allow a pin to move and place an excessive force on only a part of a connection. Some shackles use a threaded-type pin. If the pin is not completely threaded into the shackle part, the shackle or pin can be bent or broken when force is applied.

When using pins with safety keys, such as the type in tow bars, all pins in a vertical plane should have their heads pointing up. Then, even if the safety key should break or fall out, the pins will remain in position if the load shifts.

## SPEED

Take care when towing vehicles so that you maintain control of both the towing and towed vehicles. Consider terrain, weather, and road conditions. Never exceed tow speeds listed in operator's manuals.

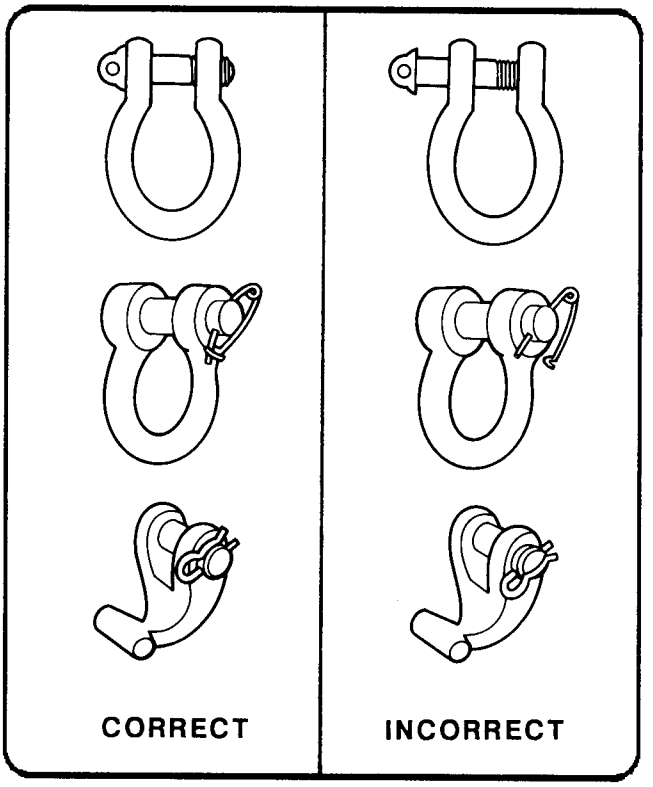



Figure 4-3. Safety Keys and Shackle Pins

# RECOVERY PROCEDURES

In any recovery operation, use the following eight-step method.

- **STEP 1. RECONNOITER AREA**

Check the terrain for an approach to the load; then determine the method of rigging and the availability of natural anchors. As with a tactical mission, a recovery crew must know the problem before making decisions.

Make a complete ground survey of the area; then select the best route of approach to the disabled vehicle to prevent possible disablement of the recovery vehicle.

When selecting the evacuation route, ensure the military route classification number will support the combination vehicle classification (recovery plus towed vehicles). Refer to FM 5-36 for further information.

- **STEP 2. ESTIMATE THE SITUATION**

Estimate the resistance created by the load and determine the capacity of the available effort. For most recovery operations involving winching, the available effort would be the maximum capacity of the winch. In some recovery operations, the maximum distance between the winch and the disabled vehicle could be restricted, making the available effort as little as half the winch capacity.

- **STEP 3. CALCULATE RATIO**

Compute an estimated mechanical advantage for the rigging by dividing the resistance of the load (step 2) by the available effort (the capacity of the winch).

- **STEP 4. OBTAIN RESISTANCE**

Compute the tackle resistance and total resistance. Determine the resistance of the tackle. The

percent of the load resistance as determined in step 2 is multiplied by the number of sheaves in the rigging. The determined resistance of the tackle added to the load resistance equals the total resistance.

Total effort available is winch capacity multiplied by the mechanical advantage (as computed in step 3). If effort available is more than total resistance, proceed to step 5. If it is less, go to step 3 and add mechanical advantage.

- **STEP 5. VERIFY SOLUTION**

Compute line forces to compare with the winch and dead line capacities. Divide the total resistance (step 4) by the mechanical advantage (step 3). The result is the force of the fall line. The fall line force must be less than the capacity of effort. Therefore, this step of the recovery procedure is the key step to solving the problem.

When verifying the solution, if the computed fall line force is greater than the effort, the mechanical advantage must be increased. Note that no physical work has occurred up to this point. As a result, no time is lost moving equipment or having to reerect rigging equipment. Compute the dead line force, determine the required strength of equipment capacity, and choose the correct equipment to use as dead lines.

- **Step 6. ERECT RIGGING**

Orient the crew, instruct them to assemble the tackle, and then move to a safe location. Advise the crew members of the plan, direct them to erect the tackle, and assign specific tasks. Crew members who have finished their tasks should assist those who are having difficulty. The crew members can save time by having a thorough knowledge of the tackle to be erected and by helping each other. Observe all safety precautions!

- **STEP 7. RECHECK RIGGING**

Make sure that tackle is rigged for proper and safe operation. Direct the operator to remove most of the slack from the lines and to inspect for correct assembly. If any corrections must be made, direct the crew members to make them. Explain the details of

the operations to the operators of the recovery vehicle and the other vehicles involved. Direct operators to be prepared to watch for and act on signals. Then move to a safe location where signals can be observed by all vehicle operators.

- **STEP 8. YOU ARE READY**

Signal the operators to apply winch power and recover the load. Be alert and make sure that nothing obstructs the operations of the equipment, and that all personnel on the ground remain at a safe location.

**NOTE: This eight-step procedure should be followed during all recovery operations. To assist in memorizing these steps and their sequence, they are arranged so that the first letter of each step will spell out the word "Recovery." This plan is of value to recovery crews, for application and supervision, and also to commanders for determining the efficiency of their recovery crews and their need for training.**

**RECONNOITER AREA**
**ESTIMATE SITUATION**
**CALCULATE RATIO**
**OBTAIN RESISTANCE**
**VERIFY SOLUTION**
**ERECT RIGGING**
**RECHECK RIGGING**
**YOU ARE READY**

Figure 4-4. Eight-Step Recovery Procedure

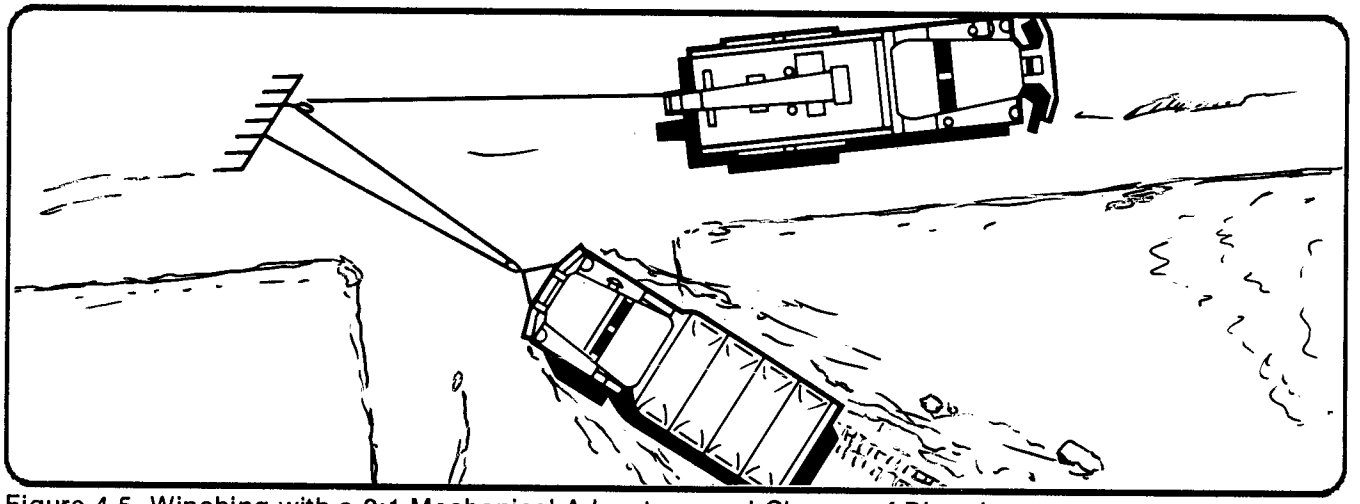


Figure 4-5. Winching with a 2:1 Mechanical Advantage and Change of Direction

# RECOVERY METHODS USING WHEEL RECOVERY VEHICLES

## TYPES AND USAGE

Recovery using wrecker trucks is performed by trained recovery personnel (see Appendix D). Use these special purpose vehicles for recovery when the methods used by the operator, crew, or platoon do not fit the situation or when their efforts have had no success. The methods of recovery performed with special purpose vehicles are winching, lifting, and towing.

**NOTE: This section summarizes winch, lift, and tow procedures. For more in-depth information, refer to the technical manuals which relate to the operation of the equipment and its specific capabilities.**

## WINCHING

Factors that must be considered, during the recovery of a mired truck using a wrecker truck, are the resistance of the load, the approach to the load, and the distance between the wrecker and mired vehicle.

Mired trucks may have a resistance greater than the winch capacity of the wrecker. Also, the wrecker may not be able to align itself with the truck due to terrain. If so, use a 2:1 mechanical advantage and change of direction block.

The direct pull is the simplest winching operation and can be used when the resistance is less than the winch capacity.

## WHEEL TOWING

Recovered vehicles must often be towed to a repair shop. The method of towing depends on the terrain and the mechanical condition of the disabled vehicle. A wrecker truck is capable of towing vehicles in the following ways:

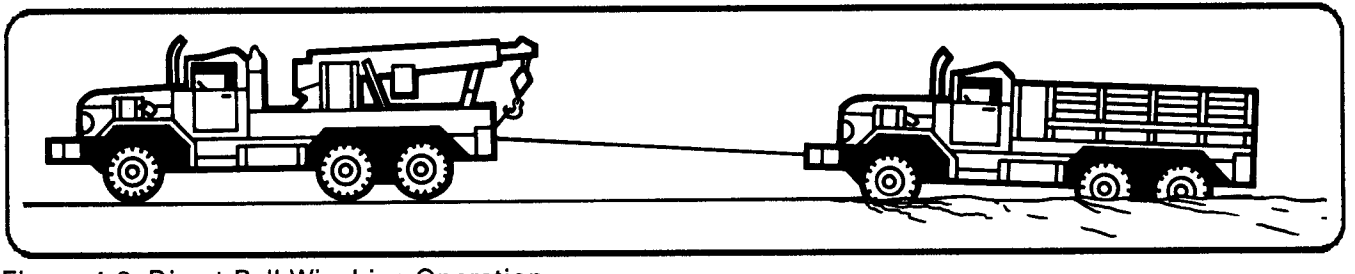


Figure 4-6. Direct Pull Winching Operation

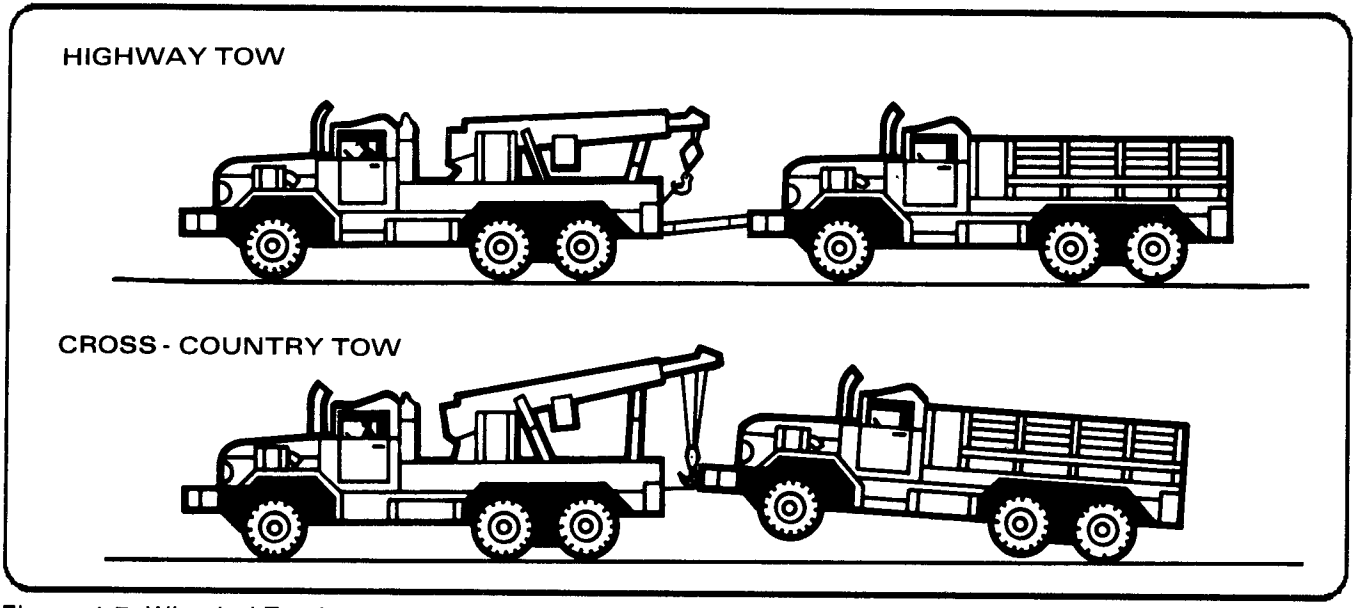



Figure 4-7. Wheeled Towing

### Highway Tow

To use a highway tow, attach the tow bar to the disabled vehicle's lifting eyes and the wrecker truck tow pintle. All wheels of the towed vehicle are on the ground. A driver is not required in the towed vehicle.

*CAUTION:*

*Safety chains must be used in addition to the tow bar. Properly used, safety chains will retain a towed vehicle should the tow bar fail or become disconnected. Cross the chains under and around the tow bar. Fasten to the shackles of the towing vehicle around a structural member or the underside of the vehicle to be towed. Leave sufficient slack for turns, but not enough to come in contact with road surface.*

### Cross-Country Tow

Over rough terrain, a cross-country tow controls the towed vehicle better. To rig for the cross-country tow, attach a chain-lifting sling or the hoisting bar between the truck's front lifting shackles. Attach a tow chain from the wrecker tow pintle to the disabled truck's lifting shackles. Place the hoist block hook in the lifting sling approximately 12 to 18 inches off the ground.

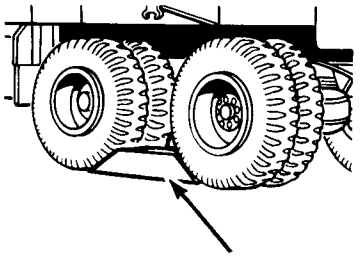
Extend the boom as little as possible to remove the slack from the tow chain to keep the towed vehicle from ramming into the rear of the wrecker truck. Support the boom with the shipper braces to prevent impact loads on the crane mechanism.

**WARNING:**

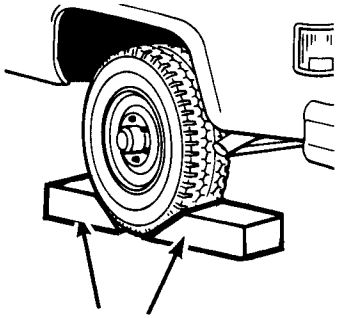
**Extreme caution should be exercised to avoid damage to the towed vehicle. If at all possible, use the lift towing procedure before using cross-country tow or highway-tow procedures.**

### Lift Tow

If the front end of the vehicle is damaged, use lift-tow procedure even though the disabled vehicle is being towed on the highway. Attach axle clamps to the front axle of the disabled vehicle and attach the tow bar to the axle clamps. Be careful not to damage brake lines. Procedures are the same as cross-country towing except that a tow bar is used in place of the chain.



WOODEN BLOCK



WOODEN BLOCKS

## HOOKING UP TO VEHICLE

1. BEFORE HOOKING UP TOW BAR OR DISCONNECTING DRIVE OR PARKING BRAKE, CHOCK VEHICLE WITH BLOCKS SO THAT IT CANNOT MOVE.

2. PLACE A BLOCK OF WOOD OR OTHER SUITABLE OBJECT BETWEEN REAR TIRES OR IN FRONT AND BACK OF ONE TIRE. MAKE SURE OBJECT EXTENDS FULL WIDTH OF TIRE.

## UNHOOKING FROM VEHICLE

1. BEFORE UNHOOKING TOW BAR OR HOOKING UP DRIVE OR PARKING BRAKE, CHOCK VEHICLE WITH BLOCKS SO THAT IT CANNOT MOVE.

2. PLACE A BLOCK OF WOOD OR OTHER SUITABLE OBJECT BETWEEN REAR TIRES OR IN FRONT AND BACK OF ONE TIRE. MAKE SURE OBJECT EXTENDS FULL WIDTH OF TIRE.

**CAUTION:** FAILURE TO REMOVE THE BLOCK COULD RESULT IN DAMAGE.

Figure 4-8. Chocking/Blocking Wheeled Vehicles.

NOTE 1: A key towing principle is to keep as much weight as possible on the front wheels of the towing vehicle. Do this by keeping the towed vehicle as close as possible to the towing vehicle without causing damage to either vehicle. Raising the boom slightly (one or three holes), not extending the boom or only extending it as little as possible, and keeping the tow bar as short as possible, will all help keep weight on the front axle of the towing vehicle.

NOTE 2: Use extreme care when towing disabled vehicles. Check the disabled vehicle's technical manual for vehicle preparation, precautions that must be taken, and vehicle speed.

## RECOVERY METHODS USING TRACK RECOVERY VEHICLES

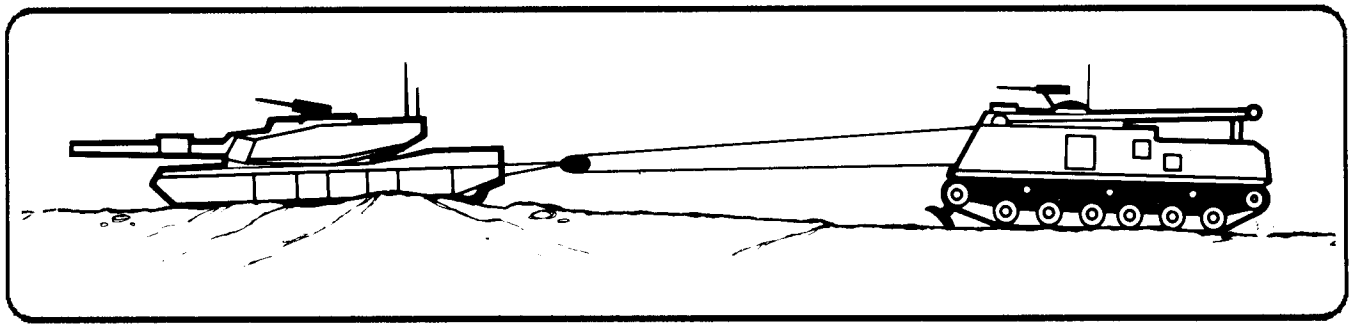


Figure 4-9. 2:1 Mechanical Advantage

## WINCHING

Recovery with one recovery vehicle is used for recovering most mired track vehicles. To prepare for winching, position the recovery vehicle as nearly in line as possible with the mired vehicle. It must be at a distance to obtain maximum winching capacity. A greater mechanical advantage may be required.

There are several advantages in using a M88A1 when recovering mired track vehicles.

The M88A1 has a constant pull 70-ton main winch which will affect most recoveries on a single line. This allows the recovery crew to position the M88A1 as close as practical to the mired vehicle, allowing

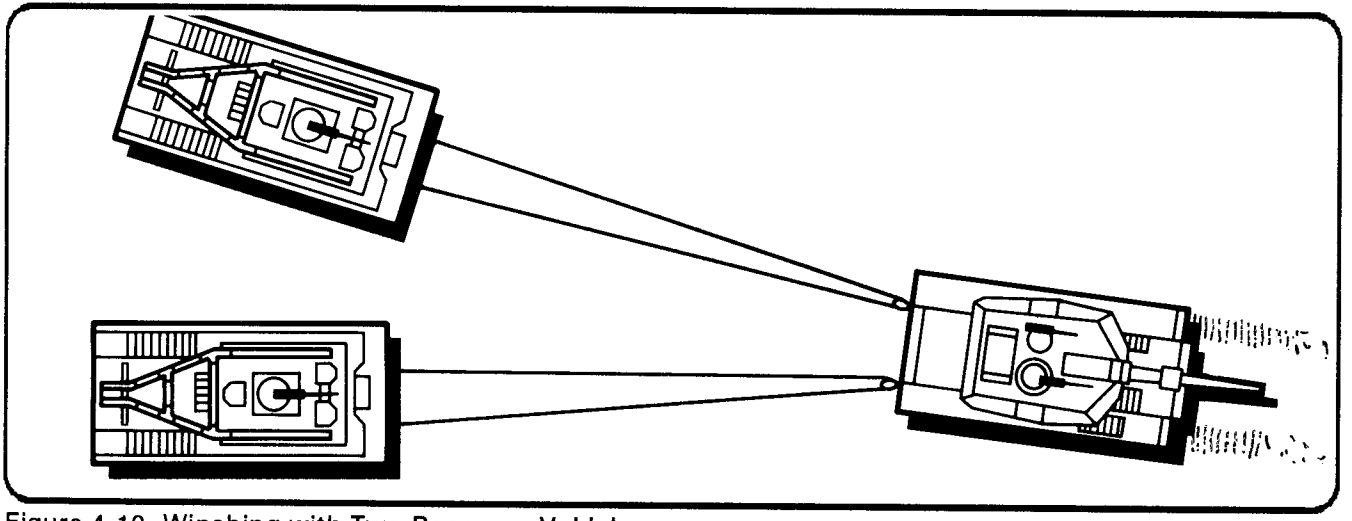


Figure 4-10. Winching with Two Recovery Vehicles

distance for the mired vehicle to get on solid ground. Testing has shown that the flat smooth hull of the Abrams-series tanks provide less resistance than is expected. This should allow most of the mired tanks to be recovered using a single line pull from the M88A1.

Recovery with two recovery vehicles is used only when the load resistance of a mired track vehicle is so great that the calculated fall line force is more than the winch capacity of one recovery vehicle with a 3:1 mechanical advantage.

To take full advantage of their winch capacities, the recovery vehicles are positioned side by side. The same length of winch cable can then be used. Rig each recovery vehicle for 2:1 mechanical advantage. Attach the snatch block of each rigging to a tow lug on the mired vehicle. To synchronize winch speeds, both recovery vehicle operators should use the hand throttle to set engine speed at the desired RPM and compensate with the winch control lever to maintain taut cables.

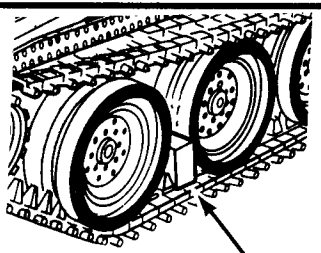
## TRACK TOWING

Although towing can be done with similar vehicles, it is often necessary for the recovery vehicle to tow a disabled vehicle to some point where repairs can be made or evacuation effected. The method of tow depends primarily on the type of terrain.

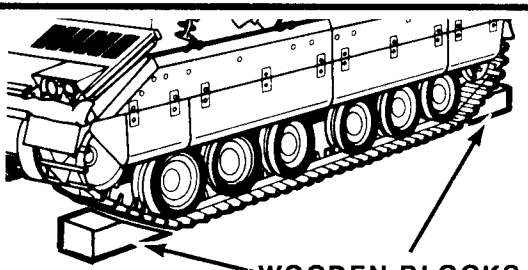
*CAUTION:*
*Take care to prevent further damage to the vehicle when towing. Do not engage the towed vehicle's transmission during towing operations. Check the disabled vehicle's -10 manual or vehicle preparation, any further precautions, and the towing speed.*

### Highway Tow

Attach the recovery vehicle's tow bar to the tow lugs of the disabled vehicle. Place the lunette of the tow bar in the recovery vehicle's tow pintle. This could be done using a small block and tackle attaching one part to the tow bar and the other to a place on the recovery vehicle higher than the tow pintle. This should allow a single soldier to raise the tow bar



WOODEN BLOCK



WOODEN BLOCKS

## HOOKING UP TO CARRIER

1. BEFORE HOOKING UP TOW BAR OR DISCONNECTING DRIVE BETWEEN DIFERENTIAL AND FINAL DRIVES, CHOCK VEHICLE WITH BLOCKS SO THAT IT CANNOT MOVE.

2. PLACE A BLOCK OF WOOD OR OTHER SUITABLE OBJECT BETWEEN TRACK GUIDES AND TWO SETS OF ROAD WHEELS OR ONE IN FRONT AND ONE IN THE REAR OF THE TRACK. MAKE SURE OBJECT EXTENDS FULL WIDTH OF BOTH ROAD WHEELS.

## UNHOOKING FROM CARRIER

1. BEFORE UNHOOKING TOW BAR OR HOOKING UP DRIVE BETWEEN DIFERENTIAL AND FINAL DRIVE, CHOCK VEHICLE WITH BLOCKS SO THAT IT CANNOT MOVE.

2. PLACE A BLOCK OF WOOD OR OTHER SUITABLE OBJECT BETWEEN TRACK GUIDES AND TWO SETS OF ROAD WHEELS OR ONE IN FRONT AND ONE IN THE REAR OF THE TRACK. MAKE SURE OBJECT EXTENDS FULL WIDTH OF BOTH ROAD WHEELS.

**CAUTION:** FAILURE TO REMOVE THE BLOCK COULD RESULT IN SEVERE TRACK DAMAGE.

Figure 4-11. Chocking/Blocking Tracked Vehicles.

to the pintle without getting between the two vehicles. Secure the pintle in the closed position. A driver is not required in the towed vehicle.

If the recovery vehicle is lighter than the disabled vehicle, a holdback vehicle or a driver to operate the brakes in the towed vehicle is required so that the towed vehicle will not overrun the recovery vehicle.

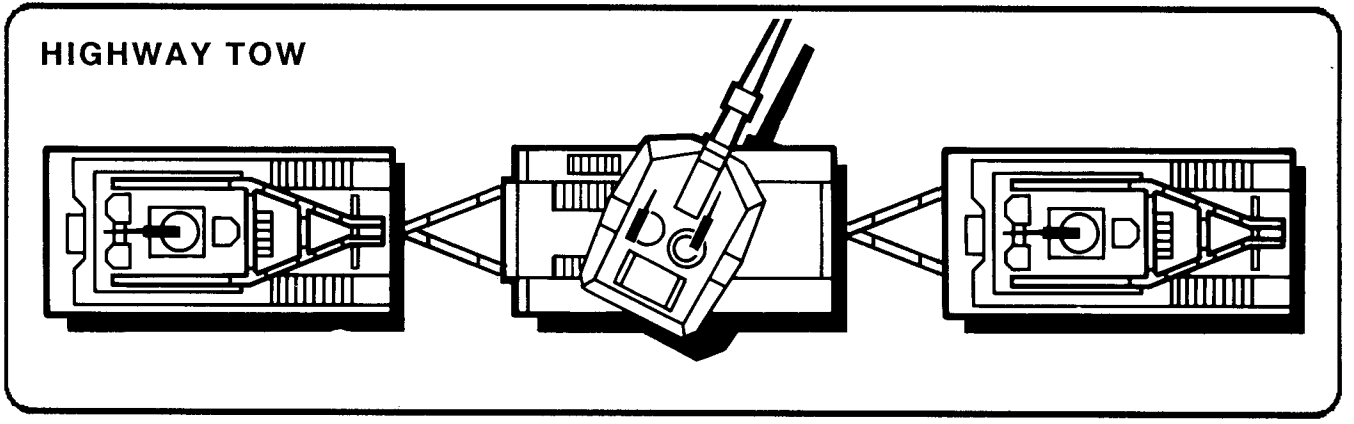



Figure 4-12. Tracked Towing

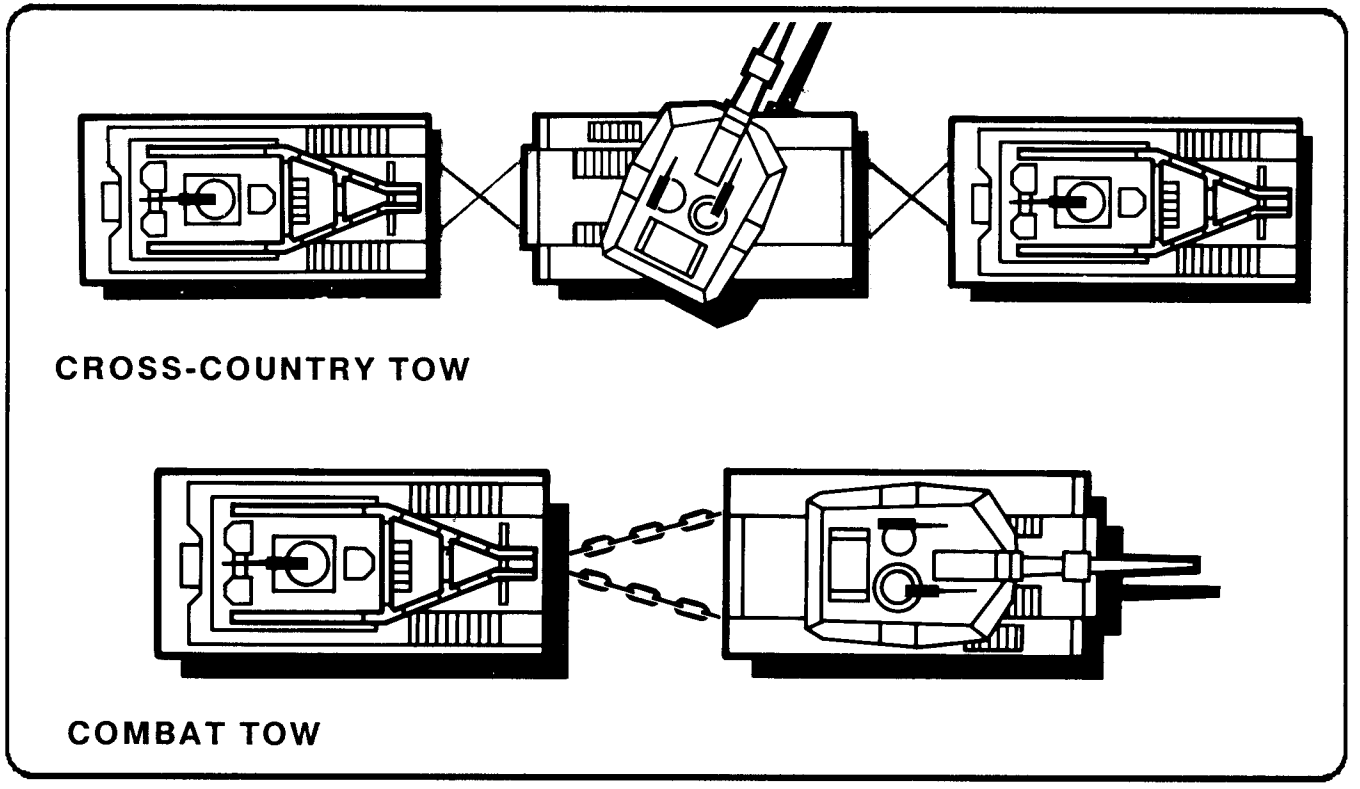



Figure 4-12 (Continued).Tracked Towing

### Cross-Country Tow

Only in extreme cases, or as a backup, will crossed tow cables be used as a method of towing. Use crossed tow cables between the recovery vehicle and the disabled vehicle as when towing similar vehicles. A holdback vehicle or a driver to operate the brakes in the towed vehicle is required so that the towed vehicle will not overrun the recovery vehicle.

### Combat Tow

Use combat tow to make a towing connection under small-arms fire to provide the least possible exposure of personnel. Attach the lifting V-chain to the recovery vehicle's tow pintle before moving it to the disabled vehicle. Move the recovery vehicle into the danger area. Back it up until contact is made with the front of the disabled vehicle. If possible, a crew member in the disabled vehicle can connect the V-chain legs to the front tow hooks of the disabled vehicle. The recovery vehicle then moves out, towing the disabled vehicle. Do not use combat tow for distances greater than one-quarter mile. Conditions permitting, change the towing procedure after that distance.

## TOW BAR HANDLING

Before attempting to tow a disabled vehicle, make sure you are familiar with the location, features, and operation of all components of the tow bar. Some tow bars have operator's instruction decals mounted on them. Ensure the proper tow bar is used based on the equipment being towed. Tow bars can be used to tow any vehicle up to the gross weight of the tow bar's towing capacity.

Before attaching tow bar to a disabled vehicle, chock wheels and/or set emergency brake. After attaching tow bar to a disabled vehicle, remove chocks and release emergency brake before moving.

Refer to disabled vehicle's technical manual for proper towing procedures (for example automatic versus standard transmission, and so forth).Ensure the proper pin assemblies are in the clevis holes and always be sure the quick release pins are properly secured. They snap automatically.

## TOWING OPERATIONS ON GRADES

Towing a disabled vehicle is never easy, but towing up or down a grade can be even more difficult and dangerous. While towing a disabled vehicle, do not attempt to negotiate a grade (either up or down) greater than 25 percent unless you have the express permission of your commander.

**NOTE: Under no conditions will you ever negotiate a slope greater than 30 percent while towing a vehicle.**

In order to know which grades to avoid, you have to know how to classify them. Grades are defined in terms of percent, or the amount of a grade's vertical height (rise) over its horizontal length (run). If a road gains 25 feet of height over 100 feet of length, it is classified as a 25 percent grade.

The best way to classify a grade is with a surveyor's level, which will be BII on the Improved Recovery Vehicle, M88A2. The operator stands at the top (or bottom) of the hill, and chooses a point as close to the bottom (or top) of the hill, as possible where he will be traveling. The operator then looks through the sight of the level at the point he has chosen and turns the level knob until he sees the level bubble centered between the witness marks. He then just reads the percent grade off the indicator.

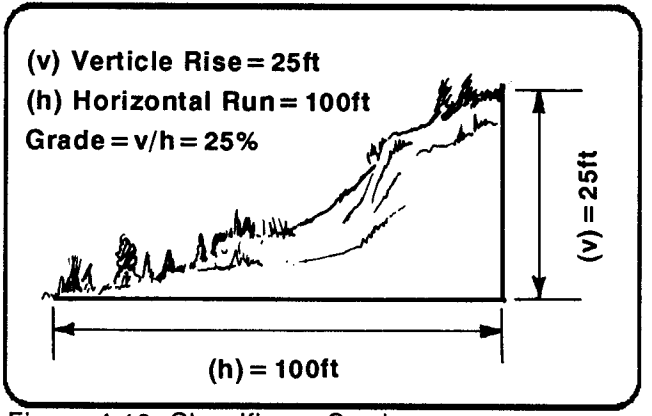


Figure 4-13. Classifing a Grade

An expedient method uses a small level, a 10-inch piece of flat wood and a ruler. Lay the piece of wood on the steepest part of the grade, with the length of wood running up and down hill. Put the level on the piece of wood and start to raise the downhill side of

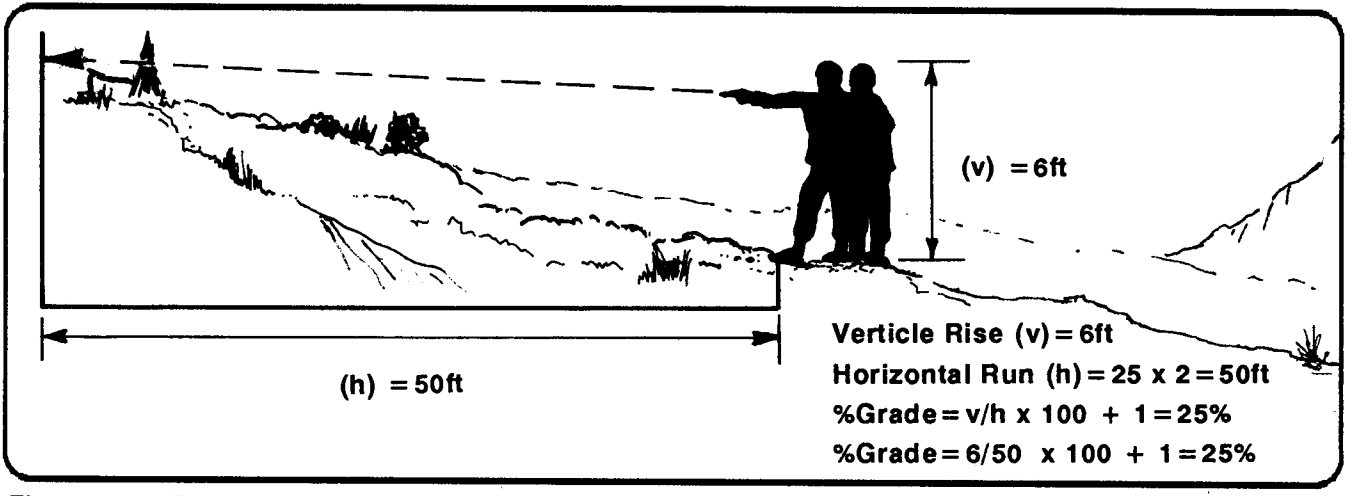



Figure 4-14. Eyesight and Pace Method

the wood up, until the bubble in the level is between the witness marks. Measure the distance between the road and the bottom of the wood. If it is 3 inches, you are on a 30-percent slope; 2.5 inches, and you are on a 25-percent slope, and so on.

One other way of determining grade is the eyesight and pace method. You need to know your height and the length of your stride. If a soldier is 6 feet tall and his step is 2 feet long, he stands at the bottom of the hill and picks a spot on the hill that is the same height as his head. He then walks to that spot counting his steps. Once he reaches the spot, he multiples his steps by his stride (2 feet) and then divides his height (6 feet) by that number multipled by 100 and adds 1.

Take the following items into consideration while doing your terrain analysis.

- Trails/grades with sharp curves mean additional control is needed during ascending and descending. There is no safety zone in case of a run-away load.

- Inclement weather (rain, snow, ice) will naturally affect the road conditions, making them more likely to cause loss of traction.

- Dry, dusty soil can cause a loss of traction as well as wet muddy soil. Do not let the soil conditions fool you.

If you have to shift into first gear to climb a grade, there is a good chance it is too steep to descend that way with a towed load. Check it before descending.

If you can find a way around the steep grades, good. If not, what are your options? First notify your commander. Tell him the percent grade of the road, weather visibility, and what the road conditions are (wet, dry, muddy, paved). The recovery vehicle driver's experience, and the type load he is towing will play an important role in the commanders decision. If you, the driver, do not feel confident in negotiating the grade, make that known to the commander. The best course of action may be to get the most experienced wrecker/recovery vehicle operator on the site to take the mission.

Other options may be:

- Try using a braking vehicle in back of the towed load.

- For tracked vehicles, hook up the final drives, start the engine (if possible; if not, brakes of disabled vehicle will not work) and try using the disabled tracks brakes in conjunction with the recovery vehicle. This will call for communication between vehicles, and very good coordination. Remember to disconnect the final drives again at the bottom of the hill.

- In some cases, winching the disabled vehicle downhill might be possible.

In summary, ensure you conduct a good route reconnaissance on your way to the disabled vehicle's site. Avoid all hills or roads with a grade of 25 percent or greater when at all possible while towing a load. If not, notify your commander, and take proper precautions.

## RECOVERY WITH THE FIFTH WHEEL TOWING DEVICE

The FWTD converts a fifth wheel tractor into a vehicle for lift-towing. The tractor requires no modification to accept the device. It can lift-tow disabled vehicles from the front or rear.

---

*CAUTION:*

*Never exceed gross vehicle weight or gross axle weight rating of the tractor the FWTD is mounted on. The tractor on which the device is installed should be the largest available for use and have a long wheel base. Handling characteristics of the towing vehicle will be adversely affected when less than 50 percent of front axle weight remains on front wheels. As in all lift- tow operations, CAUTION must be exercised.*

---

### Towing From Rear End of Disabled Vehicle

Lower the bar to its lowest position. Back the tractor to within a foot or two of the rear end of disabled vehicle. Raise the tow bar so it is about the same height as the lower edge of the disabled vehicle's frame. Back the tractor until it almost contacts the end of the frame on the disabled vehicle. Fasten one end of a lift chain to a strong frame member on one side of the disabled vehicle. Keeping slack out of the lift chain, fasten it to the grab hook of the tow bar. Fasten the other lift chain the same way.

Release the brakes on the disabled vehicle. Raise the tow bar fully. The rear wheels of the disabled vehicle should be 4 inches above the road surface. Install boom support pins to prevent downward travel

of the boom. Secure the free ends of lift chains. Attach safety chains. Secure the steering wheel so that the front wheels do not move from the straight ahead position.

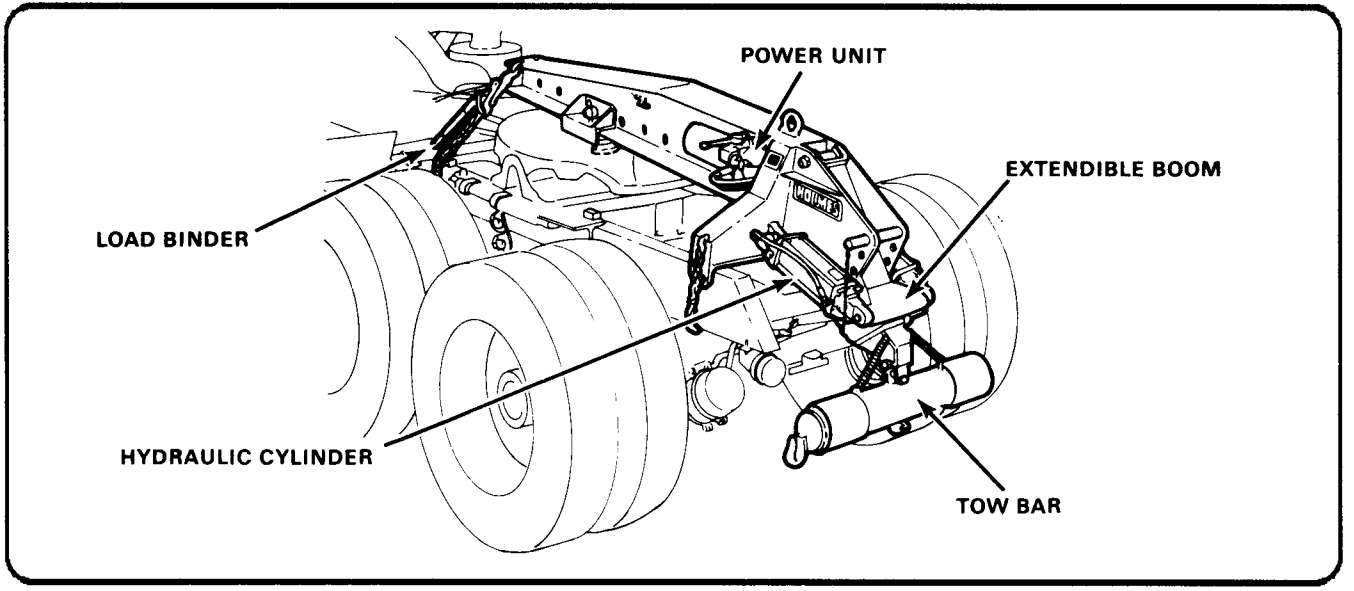



Figure 4-15. Fifth Wheel Towing Device

### Towing From Front End of Disabled Vehicle

Front end connecting procedures are similar to rear end towing procedures. However, lift chains are wrapped around the front axles not the frame rails. When wrapping chains around axles, be careful not to damage brake or air lines. Also, towing vehicles with low front bumpers may require extending the boom to lower the tow bar sufficiently.

*CAUTION:*

*SAFETY CHAINS MUST BE USED IN ADDITION TO LIFT CHAINS. Properly used, safety chains will retain a towed vehicle should the lift chains fail or come undone. Cross the chains under the tow bar and fasten their ends around a structural member on the underside of the vehicle being towed. Leave sufficient slack for turns but not enough to contact road surface.*

## RECOVERY WITH ALLIED KINETIC ENERGY RECOVERY ROPE

The AKERR kit consists of a multistrand, woven nylon rope, two large shackles, four small shackles, and a canvas bag. It is used to effect like-vehicle recovery. The concept of operation behind the AKERR is the stretch of the rope and its subsequent attempt to return to its normal length providing a sudden snatch effect. This effect provides additional recovery force. Maximum effectiveness is achieved when the recovering vehicle is of the same or greater weight class than the mired vehicle.

**WARNING:**

**Use only shackles issued with AKERR kit. Other shackles may look the same but could fail during AKERR operations. Personnel could be injured or killed or equipment damaged if the wrong shackles are used.**

Vehicles currently authorized to use AKERR are listed below:

| TYPE VEHICLE | VEHICLE WEIGHT |
|---|---|
| M109A1/M109A6 | 55,000 lb |
| M992 | 57,500 lb |
| M578 | 54,000 lb |
| M551/M551A | 36,000 lb |

*CAUTION:*

*Keep personnel 100 feet to the side of vehicle and close all vehicle hatches. If towing attachments fail, metal pieces can be catapulted at high velocity. The towing vehicle reverses as closely as possible to the bogged vehicle. The rope is connected and snaked to allow tangle-free deployment. For situations where it is not possible to get close to the bogged vehicle, extension cables may be used. Rigging for individual vehicles is illustrated in TM 9-4020-200-10. The AKERR must be connected directly to the recovery or towing vehicle. Engage gears in both recovering and mired vehicles to allow for travel in the same direction.*

On a prearranged signal, the recovery vehicle will accelerate at maximum speed. At the same time, the mired vehicle (if possible) will accelerate to assist the recovery effort. Continue maximum acceleration until the recovery vehicle is stopped or the mired vehicle is recovered.

The towing vehicle is slowed or halted; its kinetic energy is converted into the potential energy of a stretched rope. The energy is transferred by the rope into the bogged vehicle. After a slight pause, the bogged vehicle rises free. If the vehicle is not freed by the first attempt, the process should be repeated. Once free, continued towing by AKERR is possible. After recovery is effected, remove the AKERR and wash it with low pressure water.

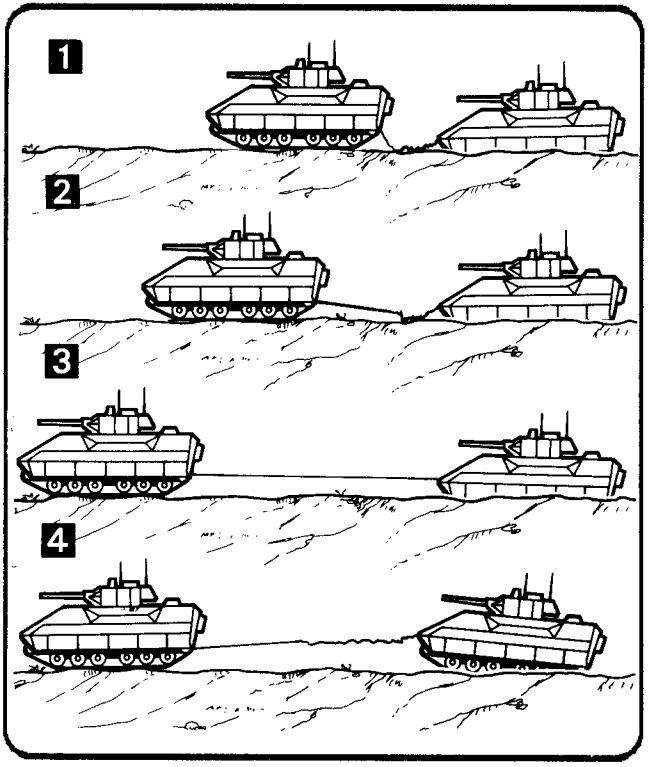


Figure 4-16. Recovery with AKERR

**THE CONCEPT OF OPERATION BEHIND THE AKERR IS THE STRETCHING ACTION OF ROPE AND THE SUBSEQUENT ATTEMPT TO RETURN TO ITS NORMAL LENGTH**

## NOSED TRUCK

The recovery of a nosed truck using a wrecker may require only a towing operation. Some situations may require all three of the wrecker's capabilities (winching, lifting, and towing) to complete the recovery.

**Example:** A 2 1/2-ton cargo truck is nosed off a narrow road and mechanically disabled. Although the apparent fleet angle of the winch cable in the figure is greater than 1 1/2 degrees, the wrecker winch has

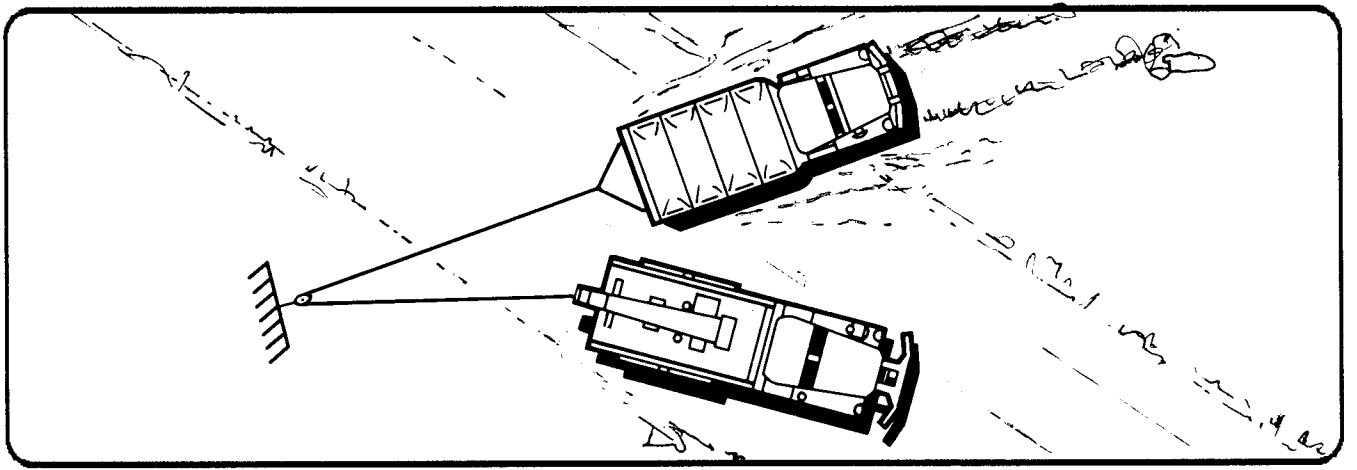


Figure 4-17. Nosed Cargo Truck

a level winding device which offsets the difference. (All vehicles with winches do not have this device.)

To perform the recovery, position the wrecker truck on the road so that the front end of the nosed truck, when pulled back up on the road, will be in line with the rear of the wrecker truck. Make a change of direction pull, using the wrecker's rear winch to pull the truck onto the road. Then, lift the front of the truck with the wrecker's outriggers in place and turn the crane to place the truck directly behind the wrecker truck to prepare for towing.

## OVERTURNED TRUCK

To upright an overturned truck using the wrecker, a sling method of attachment must be used because a pulling force applied to only one point of the frame may result in a bent frame. A sling attachment is made of two utility chains.

The sling ends are attached to the front and rear lifting shackles on the high side of the overturned truck. Then the winch cable is attached to the center of the sling.

A holding effort will be required to prevent the overturned vehicle from crashing onto its wheels. The holding force could be another vehicle, the wrecker boom, or a rope block and tackle with manpower. The attachment for the holding force is a holding sling attached to the same points on the overturned truck as the pulling sling. The holding sling is then attached to the holding force with cable, rope, or chain, making sure the holding force is attached to the center of the sling. If a holding vehicle is not available, use the wrecker boom to hold the load.

Apply power gradually to the winch until the overturned truck is past the vertical position. Then, lower the truck on its wheels with the hoist winch. When this method is used, maximum use of the boom jacks and outriggers should be made where necessary. Because of the danger of igniting spilled fuel and oil, smoking or open flames are not allowed near the overturned vehicle.

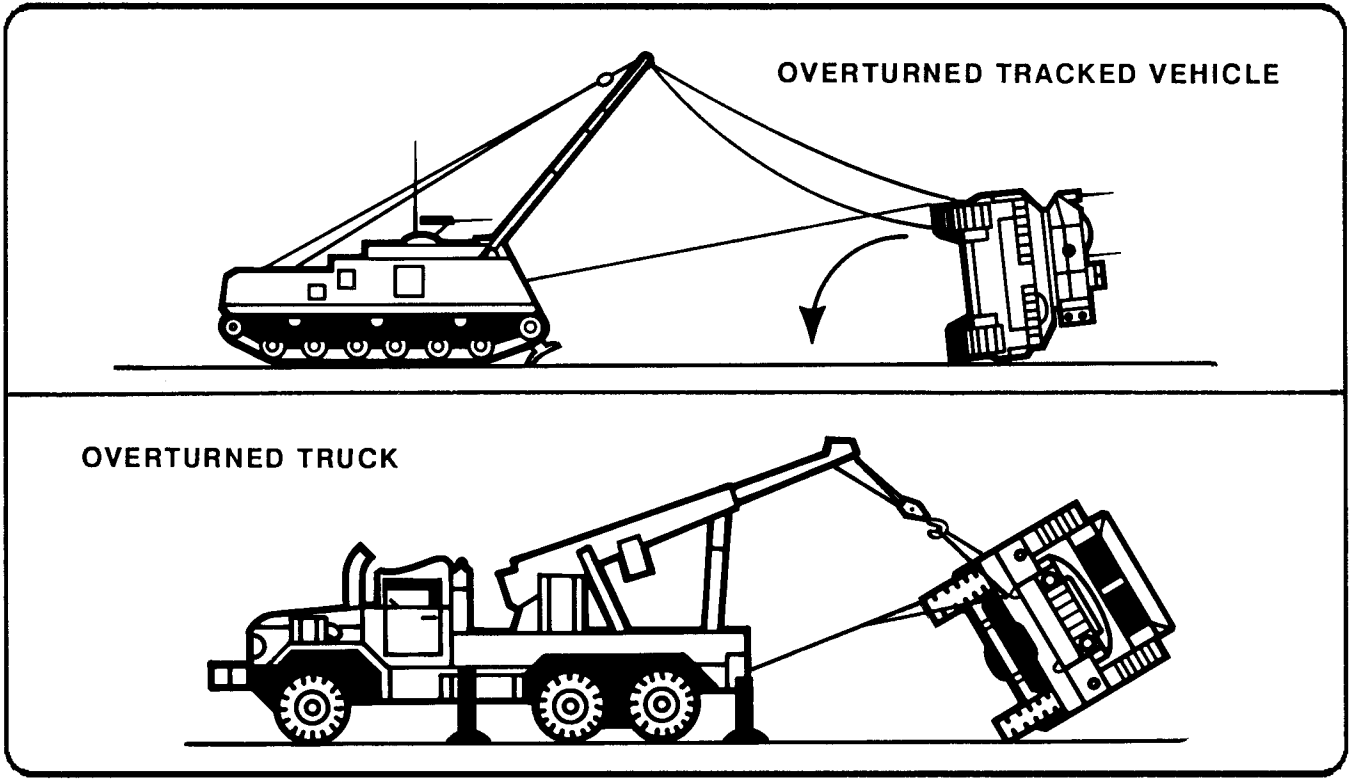



Figure 4-18. Recovery of Overturned Vehicles

## OVERTURNED TRACK VEHICLE

To upright an overturned track vehicle with a recovery vehicle, position the recovery vehicle so that it is facing the bottom of the overturned vehicle. It should be at a distance equal to the width of the overturned vehicle, plus 2 feet for safety.

For the holding source of power, rig the boom with its maximum mechanical advantage rigging, and attach its hoist block to two tow cables to form a sling. Pass the opposite ends of the sling under the track. Attach them to the front and rear tow hooks on the high side of the overturned vehicle.

For the uprighting source of power, use a utility chain to attach the main winch cable to the center road-wheel arm support housing on the high side. Apply power to the main winch until the vehicle pulls past its point of balance and is supported by the hoist rigging.

Then, by lowering the hoist winch rigging slowly, lower the overturned vehicle onto its suspension system.

## FORKLIFTS

Forklifts cannot be towed and must be transported by trailer, because of the bouncing and swaying of the vehicle. They will overturn or get stuck in mud. Use the overturned vehicle recovery procedure to upright the forklift and use the mired-vehicle procedure to recover a forklift that is stuck in mud.

## ARMORED VEHICLE LAUNCHER BRIDGE

When recovering the AVLB, the bridge has to be removed by another AVLB through hydraulic slave procedure. The bridge cannot be removed by the M88 hydraulic system because they are not the same. Once the bridge is removed, refer to the operator's manual for the towing and hookup procedures.

## COMBAT ENGINEER VEHICLE

Make sure road wheels are blocked before disconnecting final drives. When a tow bar or cables are used, a second vehicle is required when descending a grade of 20 degrees or more. A second vehicle is also required when the road conditions dictate. CEV

should only be towed from the rear unless the blade is removed from the front of the vehicle.

## MINE PLOW AND MINE ROLLER

Vehicles with mine plows and mine rollers attached cannot be towed from the front until the mine rollers or mine plows are removed. These vehicles can be towed from the rear provided the terrain and situation allows it. Once you determine how you will tow the vehicle, reference the operator's manual for towing and hookup procedures.

## CRANE, WHEEL MOUNTED

This vehicle can be towed, but obtain information on road conditions and possible restrictions along the route. Use a vehicle with an air brake system capable of producing 120 psi in the system; place the boom over the front which is the most stable position for towing. If towing more than one-fourth mile, disconnect propeller shafts from the front and rear axles. Caution must be used when turning and traveling through towns.

## ROAD GRADER

When towing the road grader for distances greater than one-half mile, direct support or general support personnel must remove the tandem drive chains. If the distance is less than one-half mile, it is not necessary to remove the tandem drive chains, and speeds must be below 5 MPH. If there is no support personnel available to remove tandem drive chains, the road grader must be recovered by trailers if the distance is more than one-half mile and it cannot be towed.

## SCOOP LOADER

This vehicle should never under any circumstances be pushed or towed. It must be moved by a flatbed trailer. In the event of an emergency where you have to tow the scoop loader, the maximum distance the loader may be towed or pushed is one-half mile at low speeds, not to exceed 5 mph.

## M9 ACE ARMORED COMBAT EARTHMOVER

When towing the M9 ACE, it must be towed from the rear. The final drives must be disconnected, to prevent damage to steering unit. When turning, turn in a wide arc to prevent undue strain on the suspension of the disabled vehicle and tow bar. Make sure the disabled vehicle is in the SPRUNG position.

## NOSED TRACK VEHICLE

Various factors must be considered before recovering a track vehicle nosed in a deep trench or ravine. If the terrain behind the nosed vehicle is level, recover by towing. If the terrain is not suitable for towing, perform a winching operation.

If the recovery vehicle cannot be safely positioned behind the nosed vehicle, move the recovery vehicle

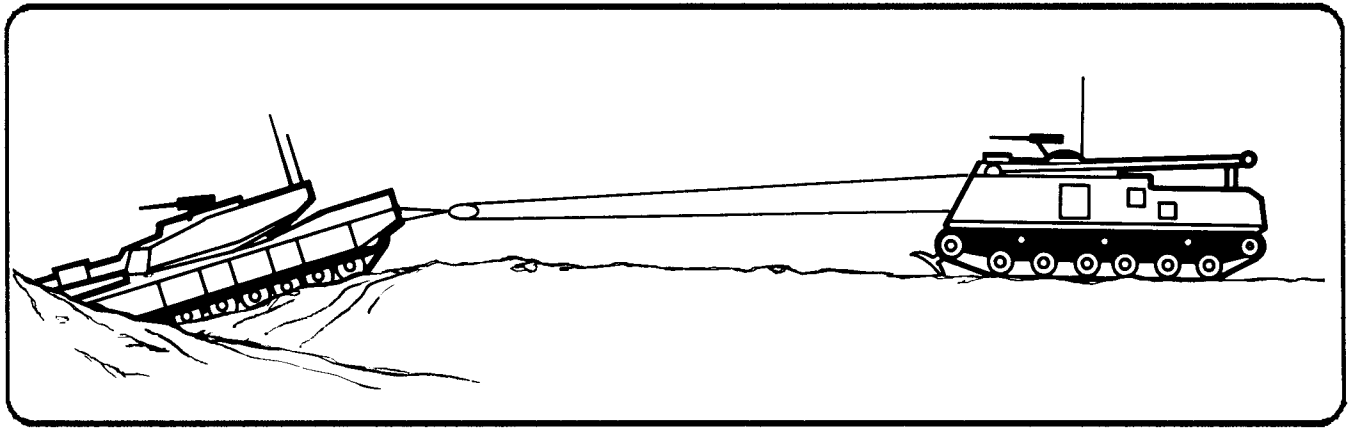


Figure 4-19. Winching a Nosed Tracked Vehicle with a Recovery Vehicle

## NOSED VEHICLES MAY BE RECOVERED BY TOWING, WINCHING OR LIFTING OPERATIONS

to the opposite side of the ditch. Using the recovery vehicle's boom with its maximum mechanical advantage rigging, attach its hoist block to the front lifting eyes on the nosed tank with a V-chain.

Lift the vehicle horizontally and pull it to the opposite side of the ditch where towing or winching can complete the recovery. If the tow hooks are accessible on the nosed vehicle, use rigging to attach them

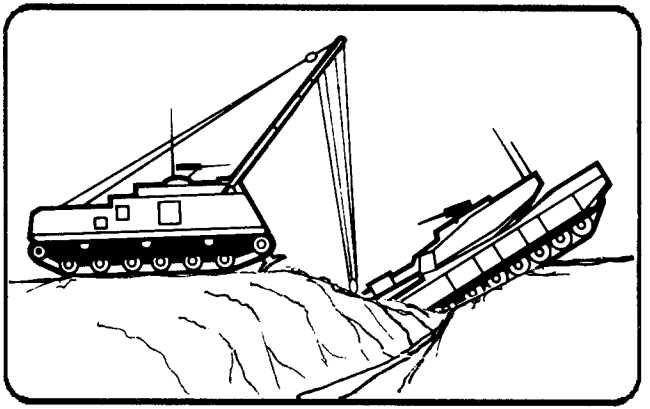


Figure 4-20. Lifting Operation

to the winch. Recover the nosed vehicle with a combination of winching and hoisting. Control the weight and movement of the disabled vehicle during the entire recovery operation by coordinating the hoist winch and the main winch.

**WARNING:**
**Because of the spilled oil, fuel, ammunition, and battery acid normally present, do not permit smoking or open flames near overturned or nosed vehicles.**

# SELF- AND LIKE-VEHICLE RECOVERY

## SOURCES OF EFFORT

The amount and type of equipment used as the source of effort during any recovery operation depends on the level of recovery. Drivers and crews should try to carry out the recovery before calling on support from a higher level. During combat, it may be imperative that cargo reach its destination at a definite time, that the personnel or cargo be picked up at a given time, or that a combat vehicle be at a given place at a specific time.

The use of similar vehicles is usually the quickest method of recovery because they are readily available. Call for recovery support only when self- or like-vehicle recovery techniques cannot be used. A mired vehicle with no winch may be able to free itself by using recovery expedient measures discussed previously.

Combat vehicles which need fuel, ammunition, or repairs not related to mobility (for example, a fire control malfunction) can tow disabled vehicles to the

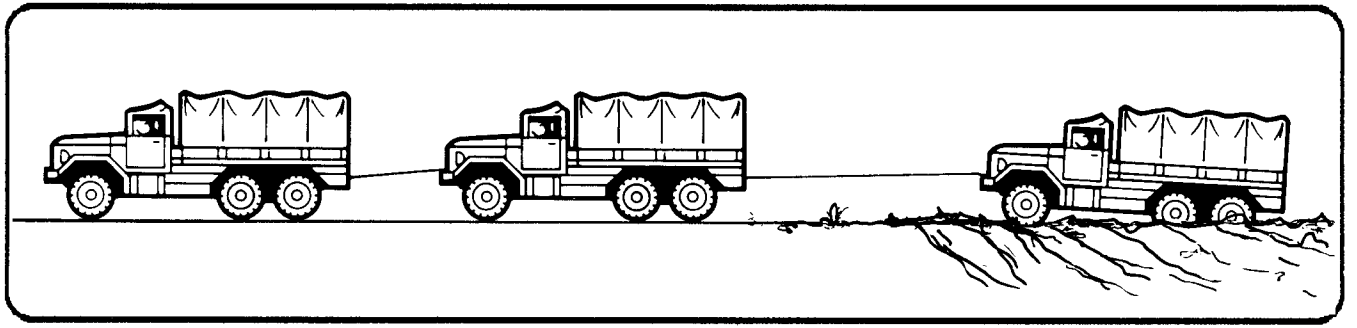


Figure 4-21. Recovery of a Mired Cargo Truck

refuel, rearm, or maintenance site. However, engaged combat vehicles should never be diverted for recovery.

## RECOVERING A CARGO TRUCK FROM MIRE

Use similar wheel vehicles as the source of effort to perform recovery by towing and winching. For vehicles not equipped with lifting shackles, attach a tow chain to the main structural members. Before towing or recovering a disabled vehicle, check the vehicle's technical manual to ensure that all physical and safety features are considered (for example, automatic transmissions, fail-safe braking systems, and articulation). This must be done so additional damage is not caused to the disabled vehicle.

To recover a mired truck by towing with a similar vehicle, use a tow chain, cable, bar, or rope between the towing vehicle and the mired vehicle. Attach it to one lifting shackle of the mired vehicle and the tow pintle on the towing vehicle. If a greater working distance is required to enable the towing vehicle to get better traction, use the towing device from both vehicles. Apply power slowly to prevent placing an

impact load on the towing device and lifting shackles. A chain, unlike a cable, will not stretch and can be broken easily by impact loading. If one towing vehicle cannot attain sufficient towing effort to overcome the resistance, use another towing vehicle in tandem with the first.

## PROPER HOOKUP WITH A SIMILAR WHEEL VEHICLE

To recover a mired cargo truck, use a truck of equal or greater capacity to perform the winching operation. A mired 2 1/2-ton cargo truck may be winched with either a 2 1/2-ton or 5-ton vehicle. All winch-equipped trucks are authorized a single sheave snatch block and one tow chain for rigging.

First, determine if the resistance of the mired truck is greater than the winch capacity. If so, a mechanical advantage is required. If it does not exceed the winch capability, position the winching vehicle in line with the mired vehicle so the correct fleet angle is obtained.

Free-spool the winch cable from the drum and attach the free end of the cable to one of the front lifting shackles of the mired vehicle and attach the

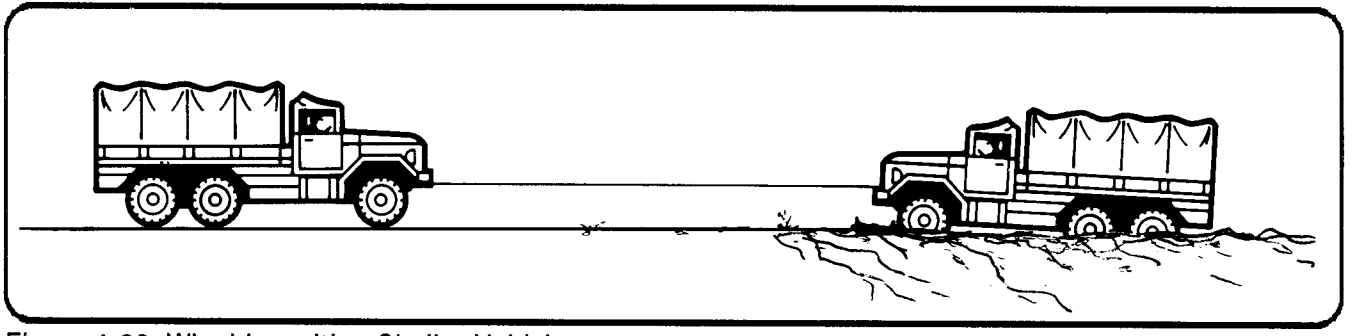


Figure 4-22. Winching with a Similar Vehicle

snatch block in the apex of the sling. Place the loop that is formed in the winch cable in the snatch block and apply power to the winch to remove the slack from the cable. At times, the winching or recovery vehicle must be anchored by more than just its weight. Place wheel blocks, chocks, or natural material in front of the recovery vehicle's front wheels.

A winch-equipped mired vehicle can perform self-recovery. Attach the snatch block to a suitable anchor and the free end of the cable to a chain sling connected to both of the mired vehicle's front lifting shackles. A fixed block will gain a mechanical advantage on a self-winching operation.

## USE OF SIMILAR-TYPE TRACK VEHICLES FOR RECOVERY

The number of track vehicles required for a specific recovery depends on the resistance to be overcome, the type of disablement, and the terrain conditions. To rig for recovery, attach the tow cables to the tow hooks of both vehicles. All main battle tanks carry two tow cables. Light-track vehicles carry one tow cable.

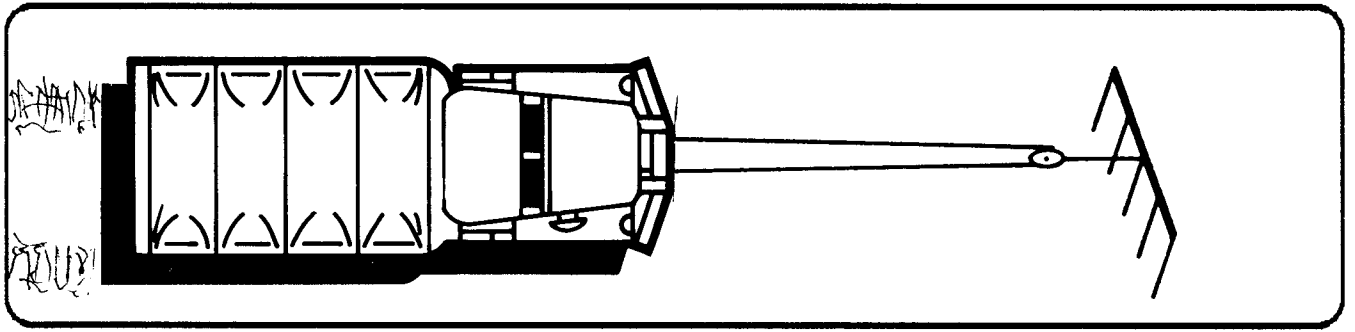


Figure 4-23. Self recovery Operation

When a vehicle with a main gun cannon tube is recovered or towed, rotate or elevate the gun tube. This prevents serious damage if the rigging fails, or the towed vehicle rams the towing vehicle.

When using two tow cables between two vehicles, make sure the cables are crossed. If a greater working distance between the pulling vehicle and the mired vehicle is required, join the tow cables together with tow hooks.

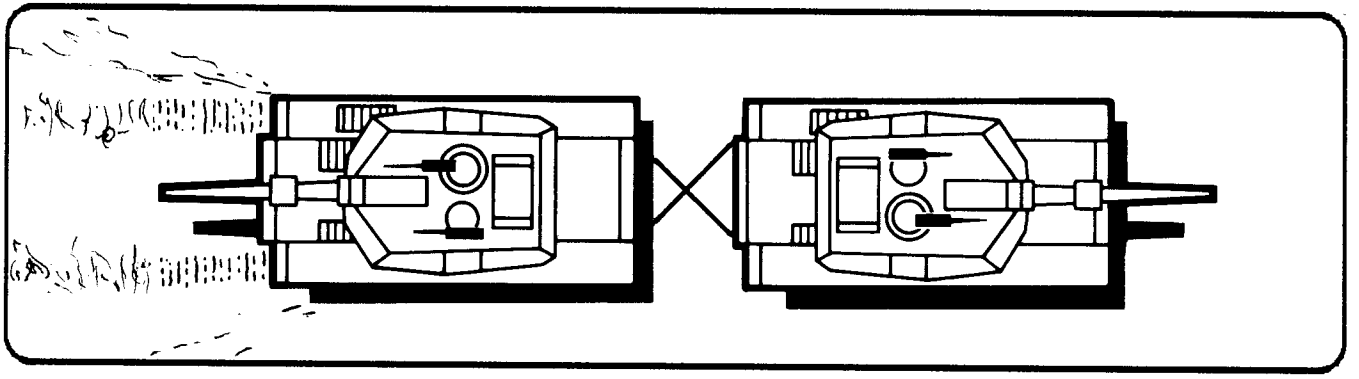


Figure 4-24. Recovery of a Mired Tank Using One Similar Vehicle

If two vehicles are required for an operation, one tow cable is enough because the strength of one tow cable is slightly greater than the pulling effort of the second pulling vehicle. However, use two tow cables, when available, to maintain alignment and equalize the pulling effort. When using two vehicles, turn the gun tube of the center vehicle to the side to prevent contact and possible damage.

## RECOVERING A NOSED TRACK VEHICLE WITH SIMILAR VEHICLES

As many as three similar vehicles may be needed to recover a nosed track vehicle. This depends on the degree to which the vehicle is nosed and the terrain conditions on which the pulling vehicles must operate. In extreme instances, a source of effort may be required to lift the front of the nosed vehicle.

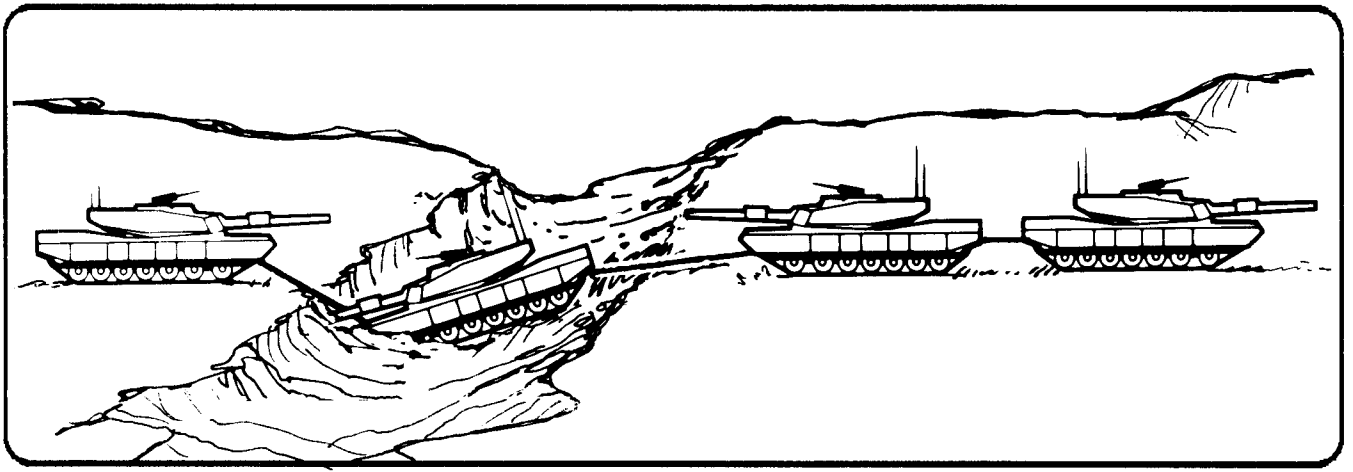


Figure 4-25. Recovery of a Nosed Tracked Vehicle with Similar Vehicles

Position the lifting vehicle to face the nosed vehicle. Connect cables of the pulling vehicles in the same way as for recovering a mired vehicle. Apply power to all assisting vehicles at the same time. The front of the nosed vehicle will rise and move toward the rear. Slowly move the lifting vehicle forward. Support the vehicle until it is recovered. If any oil or fuel has spilled in the nosed vehicle, do not run the engine until the spill is cleaned up.

## RECOVERING AN OVERTURNED TRACK VEHICLE WITH SIMILAR VEHICLES

An overturned track vehicle can be uprighted by using three similar vehicles. Use one vehicle to pull the overturned vehicle upright. Use the other two vehicles to hold and retard the fall of the overturned vehicle so that it does not crash down on its suspension system.

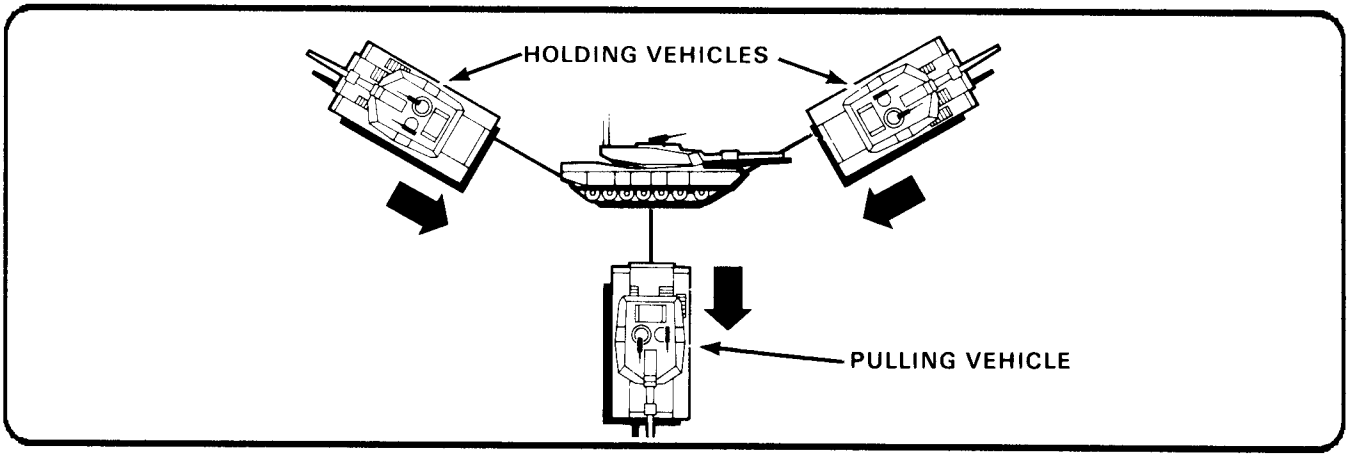



Figure 4-26. Recovery of an Overturned Tracked Vehicle with Similar Vehicles

Connect tow cables together in pairs to allow a safe working distance. Connect the cable used to upright the overturned vehicle to the nearest center road-wheel arm support housing on the upper side of the overturned vehicle. Never connect to any other part of the suspension system, turret, or the tie-down eyes.

Position the two vehicles used for holding at a 30° to 45° angle from the overturned tank with their cables connected to the tow hooks on the high side of the overturned vehicle. The holding vehicles must be positioned in this way to prevent damage to the cables, fenders, or lights of the overturned vehicle as it is uprighted.

Drivers of the holding vehicles must shift to low range. The pulling vehicle then applies power gradually in reverse, while the holding vehicles move forward only enough to keep their cables taut until the overturned vehicle passes through the point of balance. As the overturned vehicle passes through the balance point, the holding vehicles move forward slowly, supporting the overturned vehicle and lowering it onto its suspension system.

**WARNING:**

**Because of the chance of spilled oil, fuel, or battery acid, DO NOT permit smoking or open flames near the overturned vehicle. Position the vehicles so that their exhausts always point away from the overturned vehicles.**

## TOWING DISABLED TRACK VEHICLES

Tow a disabled track vehicle with a similar vehicle of the same weight class, using two tow cables (a tow bar). Cross the tow cables to keep them from getting tangled with the tracks. When towing track vehicles with only one track, there will be a difference in resistance and steering capability between a complete track on one side and road wheels on the other side. As a result, the towed vehicle will pull in the direction of the side lacking the track. This pull is com-

pensated for by proper attachment of the towing cables.

A driver must be in the towed vehicle to operate the brakes. Alternate the driver in the towing vehicle and the disabled vehicle often because of exhaust gases. Check the technical manual pertaining to the towed vehicle to determine the necessary preparations and precautions to be used to prevent further damage. Never exceed the towing speed outlined in the technical manual.

If the disabled vehicle has defective brakes or its universal joints are disconnected, use another similar vehicle for holding. Use crossed cables between the holding and disabled vehicles when available. With vehicles that are issued only one tow cable, the vehicles will be connected with crossed

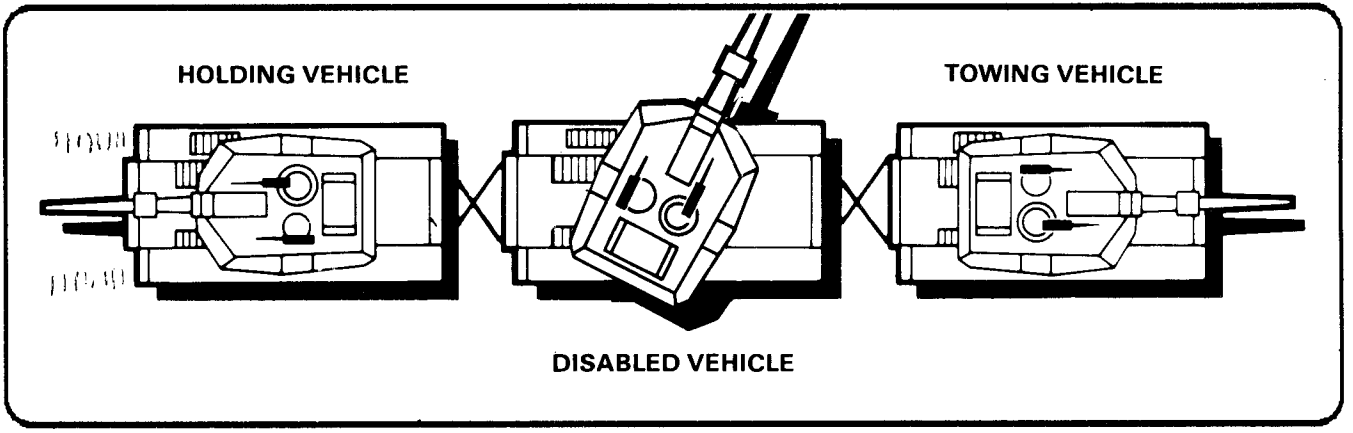



Figure 4-27. Towing a Disabled Tracked Vehicle

## USE CROSSED TOW CABLES BETWEEN THE HOLDING AND DISABLED VEHICLES WHEN ENOUGH CABLES ARE AVAILABLE

cables between the towing vehicle and the disabled vehicle. Connect a single tow cable between the disabled vehicle and the holding vehicle.

**WARNING:**

**When using a vehicle to tow other vehicles, use extreme caution, and refer to the appropriate operator's manual for further restrictions.**

*CAUTION:*

*Extreme heat is generated when using the M1 tank for towing. Damage to the towed vehicle can result. See TB 43-0001-39-1 for guidance on local fabrication of an exhaust grate heat deflector.*

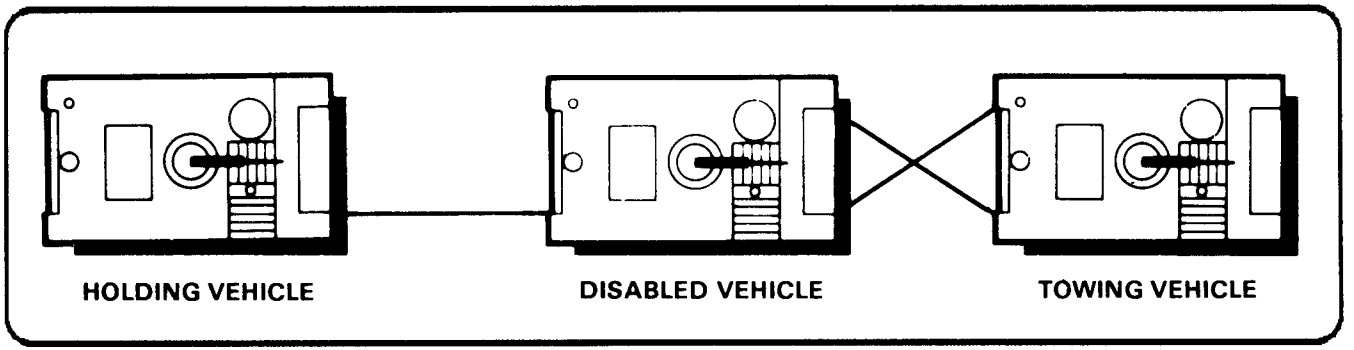


Figure 4-28. Towing with Vehicles Issued One Tow Cable

# MARINE RECOVERY

## INTRODUCTION

Many vehicles can now swim or ford. Some of these vehicles will fail while waterborne and will need recovery. Situations may be as simple as stalled, floating vehicles or as complex as submerged vehicles. The same methods of recovery apply to these situations, with a few more considerations.

In the case of floating vehicles, swiftly moving current can carry the vehicle and crew downstream. Water safety must be stressed to both vehicle and recovery crews engaged in these operations. Current and bottom conditions interact effectively to bury a vehicle, thereby increasing resistance to be overcome. When operating on beaches or rivers with soft

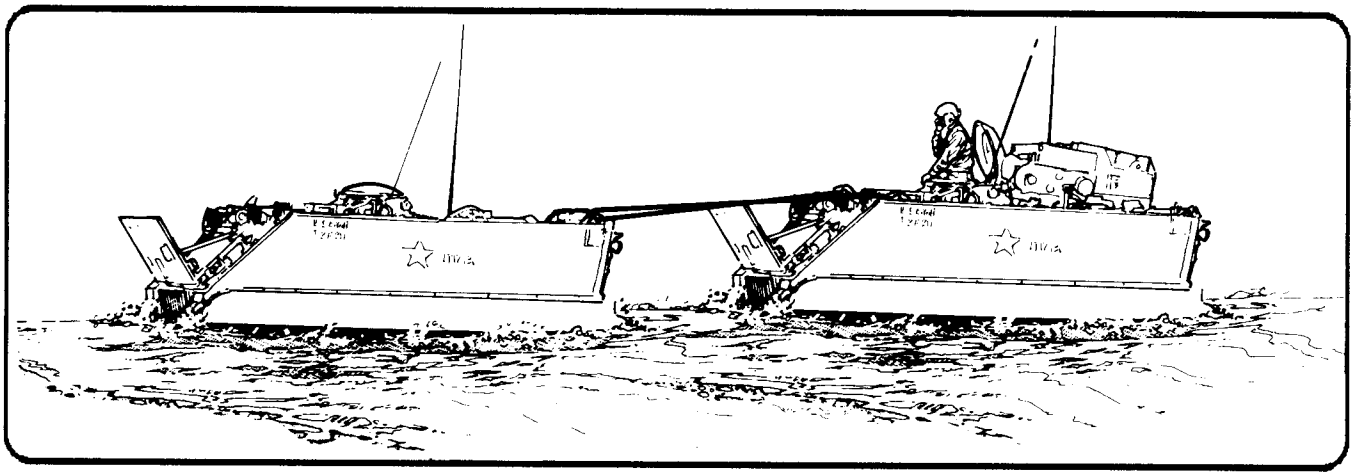


Figure 4-29. Marine Recovery with Tow Hooks and Cables Attached to Lifting Eyes

bottoms, time is critical. Recover the vehicle as quickly as possible.

## SWIMMING VEHICLES

A mechanically disabled swimming vehicle offers little resistance while on water. Compared to its rolling resistance on land, it can be recovered with little effort on water. The same rigging is made to floating vehicles as with land recovery. The only exception is that the attachments are made to the lifting eyes instead of the tow lugs. This prevents the crew from having to work in the water.

**Example:** If a similar vehicle is used for the operation, its tow hooks are attached to the lifting eyes

before entering the water. The tow cables are attached and crossed as in the normal tow procedures until the disabled vehicle is towed to shore. The tow hooks are then reattached to the tow lugs to pull the vehicle to land.

## SUBMERGED VEHICLES

If a vehicle is flooded and submerged, determine the resistance on the river bottom in the same way as on land. Consider the weight of the vehicle, the

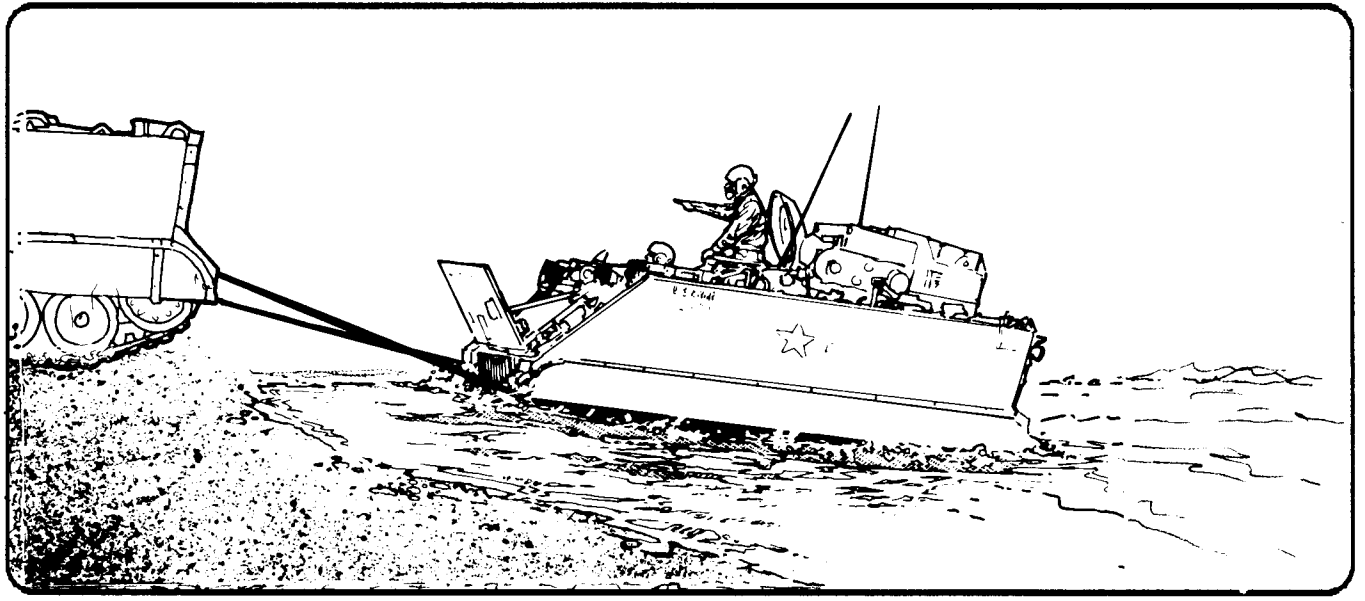


Figure 4-30. Recovery to Shore with Tow Hooks and Cables Attached to Tow Lugs

cargo, and the river bottom which may be sand, gravel, or mud. In addition, when pulling flooded vehicles from water to land, consider the weight of the water when determining the resistance. Water weight is estimated to be equal to the vehicle's weight.

**Example:** A track vehicle weighing 52,000 pounds sank. The vehicle is mired in the river bed (mud) to fender depth. Effort required to retrieve it is 156,000 pounds (2 x 52,000 lb mire factor + 52,000 lb water weight).

The first problem in underwater recovery is locating the disabled vehicle in the deep water. It may be easier to use dragging devices to locate the vehicle. Divers can then determine the orientation of the vehicle rigging. Use lines and floats to mark the location of the vehicle.

Special purpose vehicles, such as wrecker trucks and recovery vehicles, are readily adaptable to recovery operations on submerged vehicles. The winch cables of the recovery vehicles are long enough to allow winching operations from land to water in most situations.

## WATER OPERATIONS

Most vehicles currently in the inventory of our military service all have either a swim or fording capability. Because of this, extreme care for the waterways must be considered in daily operations. Vehicles involved in fording or swimming operations sometimes become disabled either from mechanical or mobility malfunctions. A vehicle that has swim capability will usually remain afloat even if the main engine should fail. This is possible because amphibious vehicles are usually equipped with an auxiliary engine and bilge pumps.

When and if complete disablement should occur during water operations, it is imperative power be restored through use of BDAR or any means available. Amphibious vehicles are at the mercy of the surf or river current when power is lost. If left afloat without power, vehicles are at risk of sinking causing futher damage to the vehicle and serious contamination of the water.If sinking does occur, all prac-

ticable efforts should be made to avoid environmental contamination. Contamination over one gallon should be reported through the chain of command.

Should a vehicle become submerged, out of sight, it is recommended qualified scuba personnel be called to assist in locating and rigging the vehicle for recovery.

### Resistance in Water

Resistance during water or land operation is determined in much the same manner. When the vehicle is fully submerged, the weight of the vehicle full of water must be considered. Vehicles that have been completely submerged for a period of time will usually be in a mired condition from sand, if in the ocean, or mud, if in a river. If in doubt, rig for the greater resistance.

Whether vehicle is upright or overturned will also be a factor on total resistance. Again, qualified divers should be used to locate and rig a vehicle for recovery. They will also be able to recommend direction of recovery depending on obstacles.

Following are some examples of resistance encountered when recovering floating type vehicles:

- Amphibious vehicle afloat, minimal - 1/64th of vehicle weight.

- Amphibious vehicles that are completely submerged - Equal to weight of vehicle. If vehicle is mired on river or ocean bottom, calculate additional resistance as you would for a land mire.

- Fording-type vehicles that have become disabled must also be considered for weight of water but, only an additional 1/8th of vehicle weight, that is, a 70-ton tank would be calculated to weigh approximately 79 tons plus any mire encountered. Mire factor in this case is figured on 79 tons.

During underwater recovery operations, air bags can be placed inside the submerged vehicle and inflated to provide buoyancy and decrease resistance. To employ air bags in this type of situation, qualified divers are recommended. The air bags or 55-gallon

**UNDERWATER RECOVERY IS USUALLY LIMITED TO MANPOWER OR LEAD METHODS**

drums need to be placed inside the vehicle in a location where they will not escape the vehicle or cause additional damage. Once the air bags are in position, inflate to recommended capacity.

### Methods of Rigging

The methods of rigging for underwater recovery are normally restricted to the manpower and lead methods. Towing from water is recommended only if disabled vehicle is located in very shallow water. The method of rigging depends upon distance from disabled vehicle, type of disabled vehicle, type of recovery vehicle available, equipment available (floats, air bags, tackle), and condition of disabled vehicle.

**Lead method.** The lead method of rigging is performed the same in water as on land. If in deep water, a boat or amphibious vehicle can transport tackle to the disabled vehicle. If the water is shallow, the tackle can be manually carried to the disabled vehicle.

**Manpower method.** The manpower method is much the same regardless of water or land. However,

floatation devices can be attached to cable every few feet or to snatch blocks and other tackle to aid in getting the recovery equipment to the disabled vehicle.

### Water Recovery

Water resistance occurs when submerged vehicles are pulled from water to land. Water resistance is estimated as additional resistance equal to the vehicle weight. Therefore, a vehicle weighing 25 tons (including cargo) would require 50 tons of effort to winch it from the water. In the same situation, resistance would increase if the vehicle went down in the surf, and the sand was partially covering the vehicle.

**Swimming vehicles.** A mechanically disabled swimming vehicle offers very little resistance. On water it can be towed with a small amount of effort compared to rolling resistance on land.

**Fording vechicl.:** Vehicles become mired, nosed, and overturned during operations just as they do during land operations. As a result, estimate resistance in the same way by considering vehicle weight and type of disablement.